

Superplasticity History, Recent Advances, and Future Potential

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Abstract

A brief historical review is presented on observations of superplasticity. The recently discovered area of high strain rate superplasticity is described in detail. Specifically, superplasticity has now been observed at extremely high strain rates of approximately $0.1\text{-}1\text{ s}^{-1}$ in many Al-based alloys, whisker-reinforced composites, and mechanically-alloyed alloys. These materials generally exhibited a strain rate sensitivity value of about 0.3 and a maximum elongation of about 300%. Experimental results indicate that the ability of these materials to undergo high strain rate superplasticity depends upon the grain size and its morphology, chemistry of the alloy matrix, and the chemical composition at the whisker-matrix interfaces for the composites. It is proposed that the presence of a low melting point region, or in some cases a liquid phase, in the alloys is responsible for the observed phenomenon of superplasticity at very high rates. These regions are present at the deformation temperature, partially as a result of solute segregation. A rheological model will be presented to describe the observed high strain rate superplasticity phenomenon.

Superplasticity has also been found in ceramics, intermetallics, and amorphous metallic alloys. The presentation will illustrate recent developments in these areas.

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